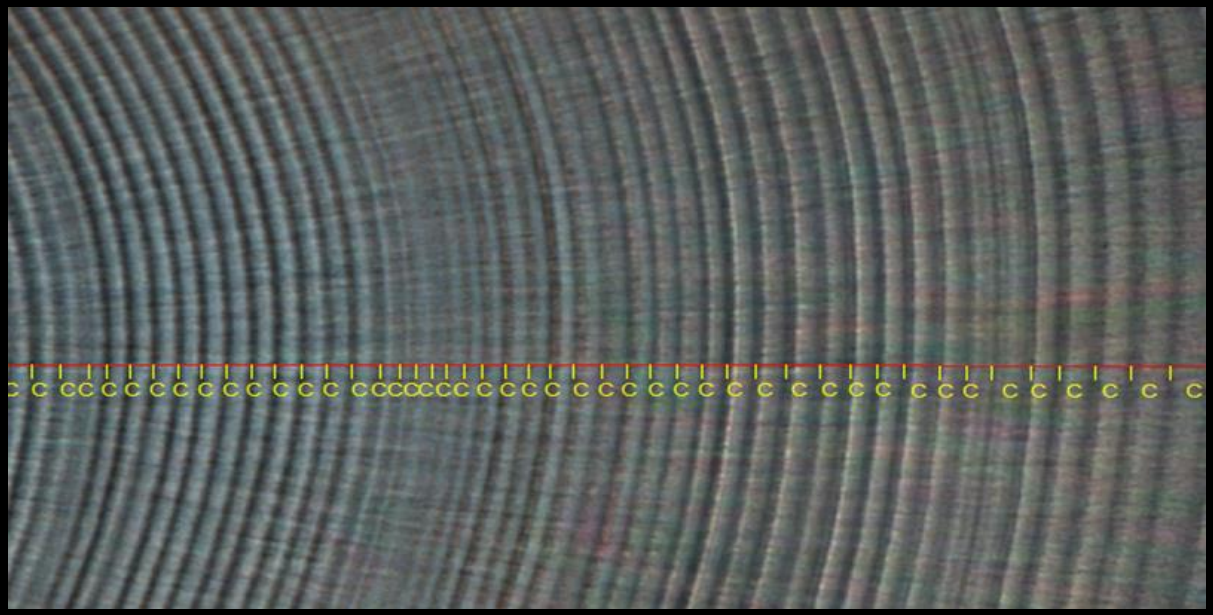
Out of sight, out of mind: what can otolith microstructure reveal about the New Zealand whitebait *Galaxias maculatus*?



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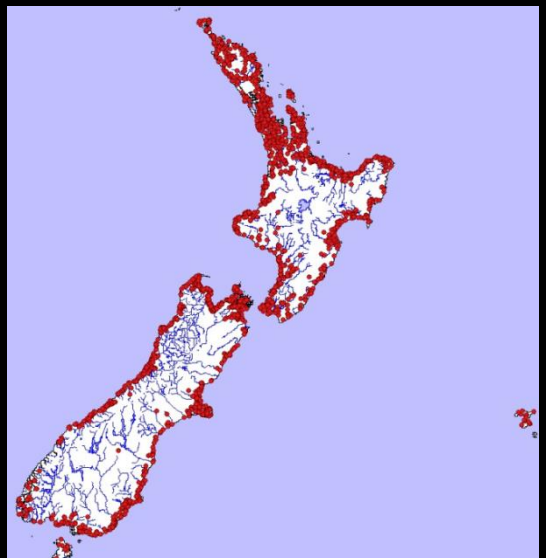
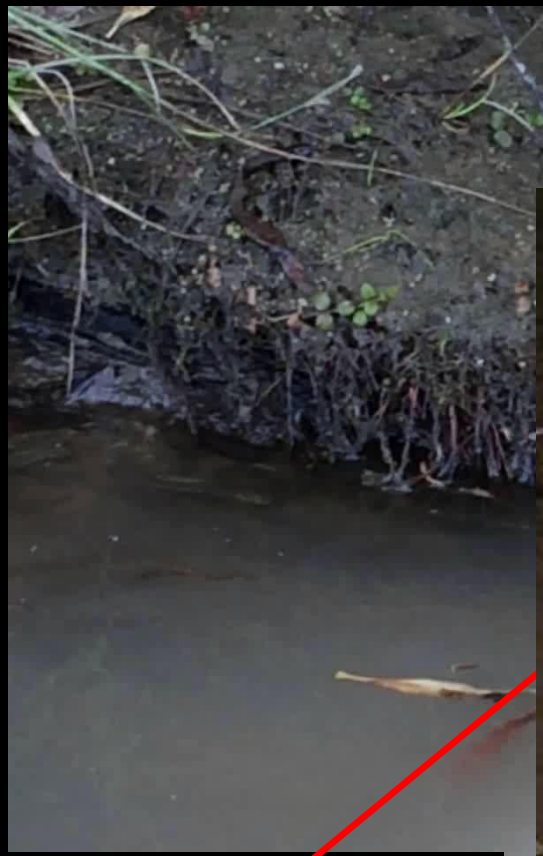
Galaxias maculatus (Inanga) ecology

- One of five migratory galaxiids
- Lowland coastal rivers
- Widespread distribution
- Environmental & biophysical gradients
  - Phenotypic variability



Gregarious Spawning



Spawning Fish

Amphidromy

Eggs

Marine larval development

Juveniles = “whitebait”

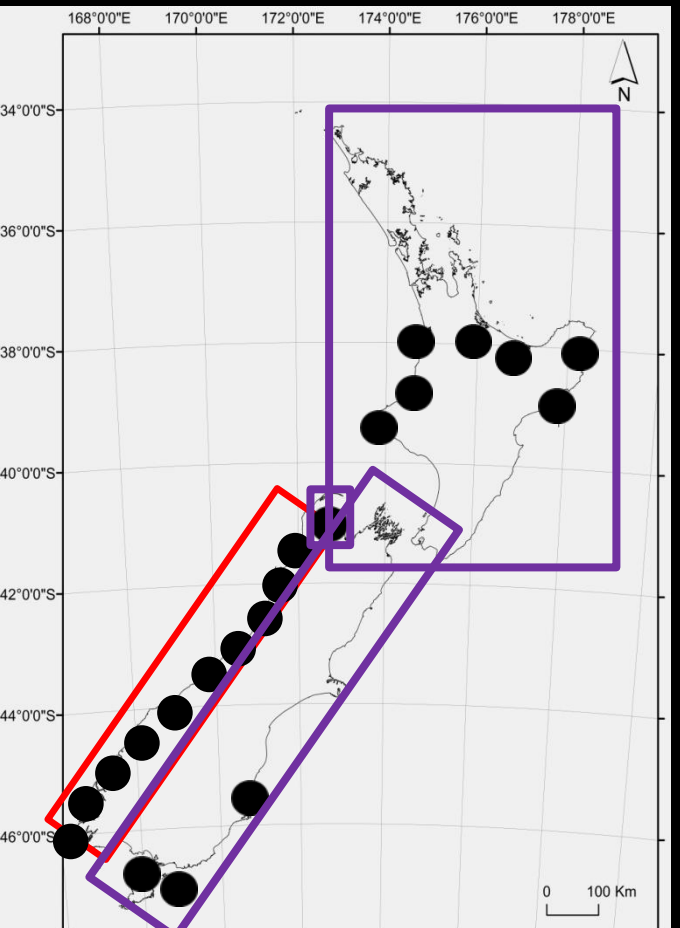
The Fishery

1kg=€50

- Cultural
- Recreational
- Commercial

Fishery management

"The whitebait fishery has always been a hit and miss *ad-hoc* affair" McDowall 1991



- >90% of whitebait catch is *G.maculatus*
- Multispecies fishery >10% others

Bucket jumpers!

(Galaxias brevipinnis)

(Galaxias fasciatus)

Management or mis-management?

- Multi- gear
  - Fishing pressure
- No licences
- No quotas
  - Data poor
- 8000 fish
  in 2 minutes!!
- Sustainable?

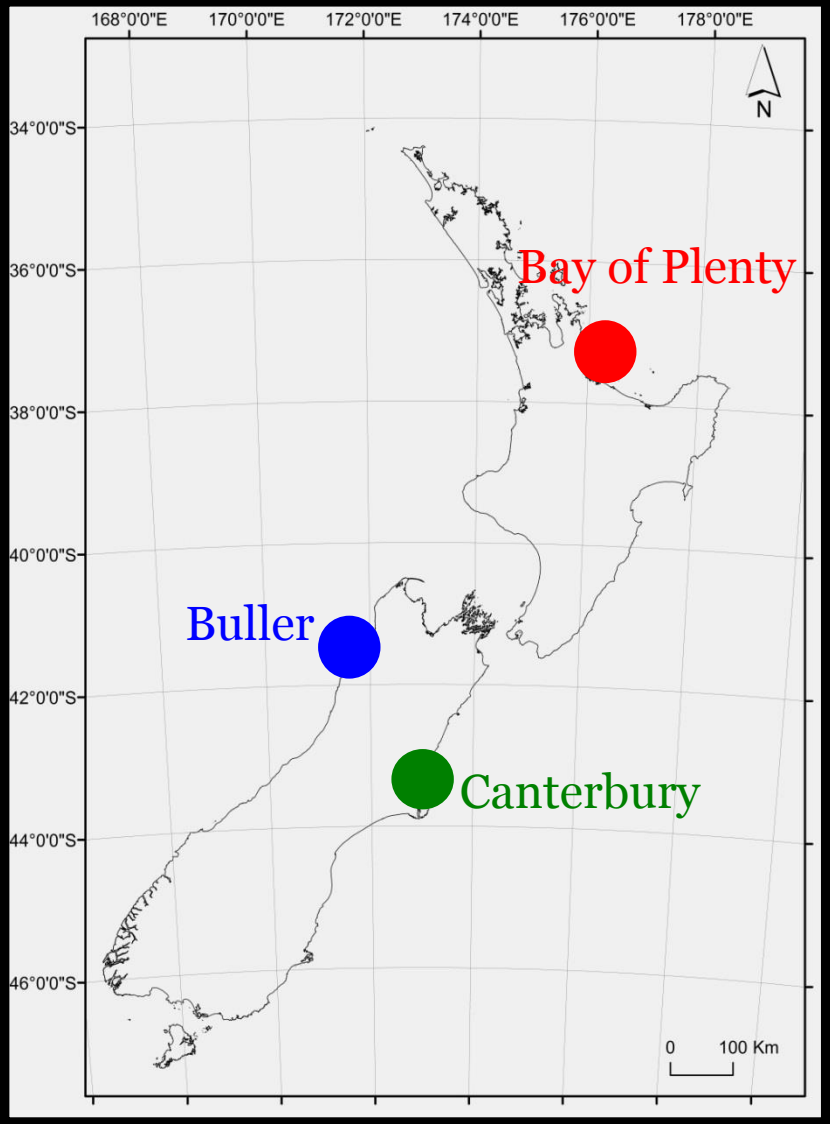
Out of sight out of mind?

- Larval “black box”
- Legacay effects
- Anecdotal evidence of population decline
- Impedes conservation and management

Key Question

Are the larval traits of *Galaxias maculatus* populations homogenous throughout New Zealand?

Methods

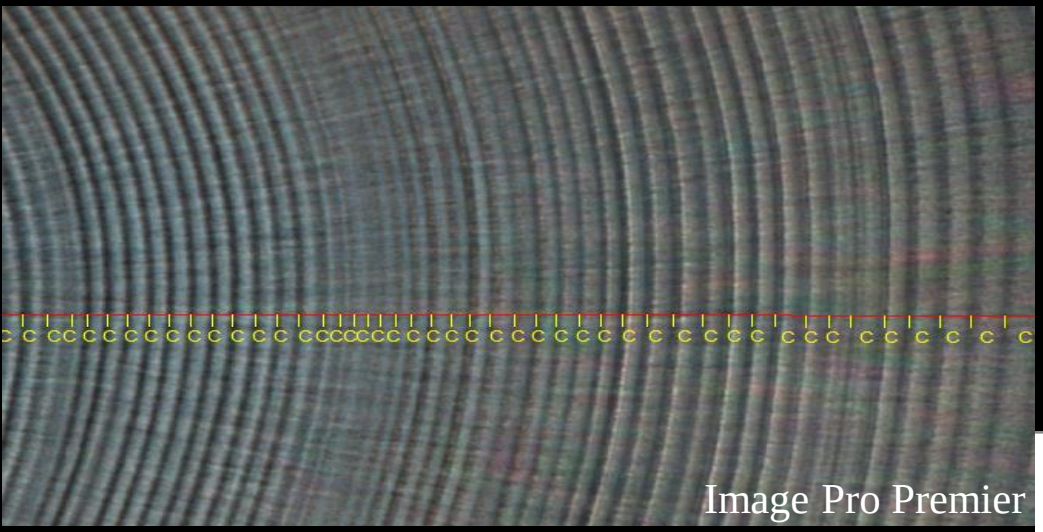


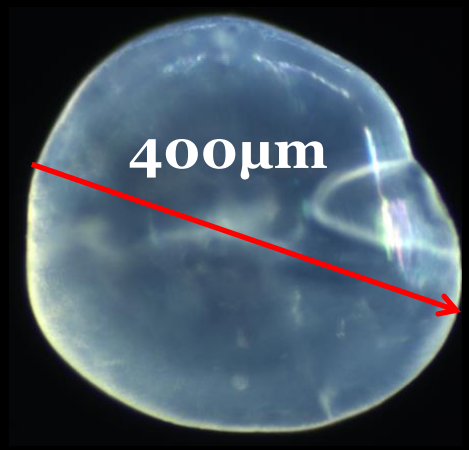
- Sampling
  3 regions
  - 3 rivers in each region
  - Fortnightly (Sept-Nov)

Otolith microstructure

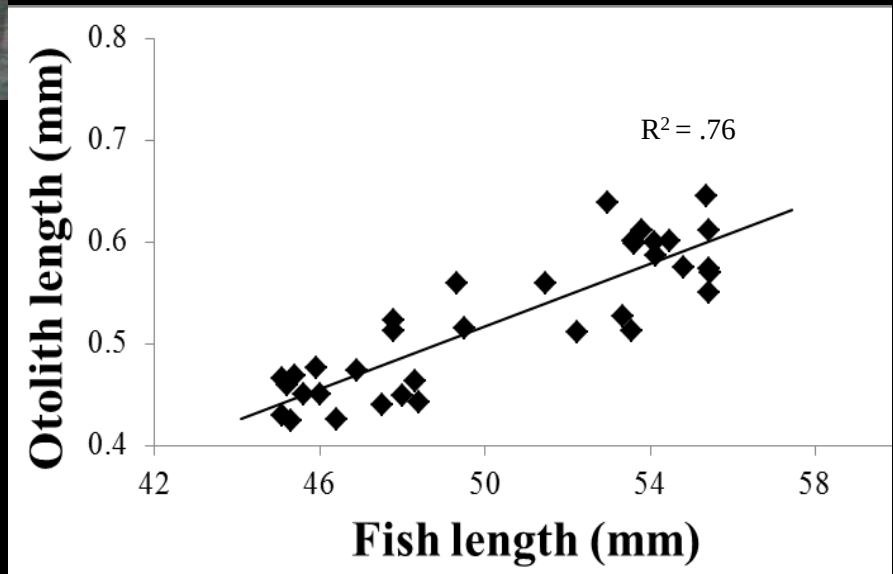
Counts → Pelagic larval duration

Increment width → Growth per day (µmd^{-1})



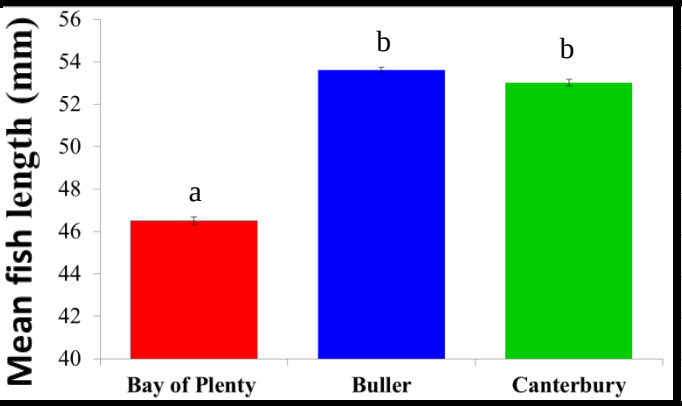


- Daily deposition validated
- Positive linear relationship fish length vs otolith length

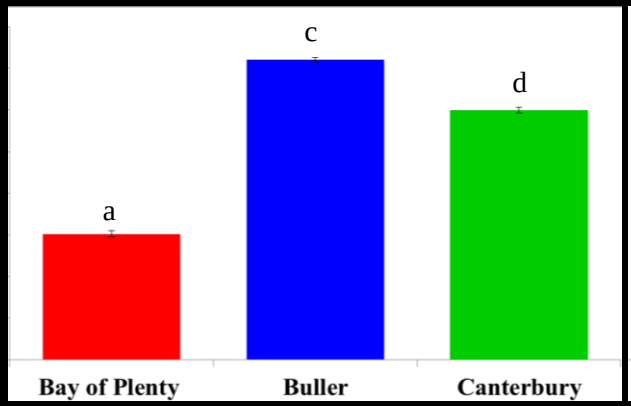


Size at recruitment

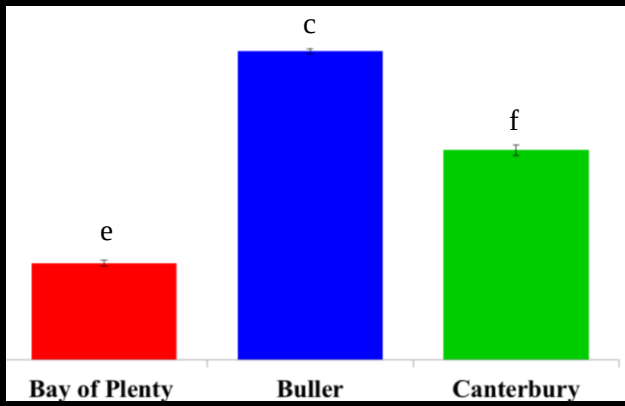
September

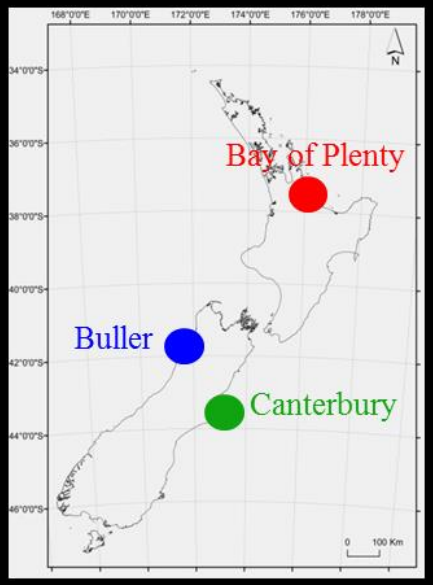


October



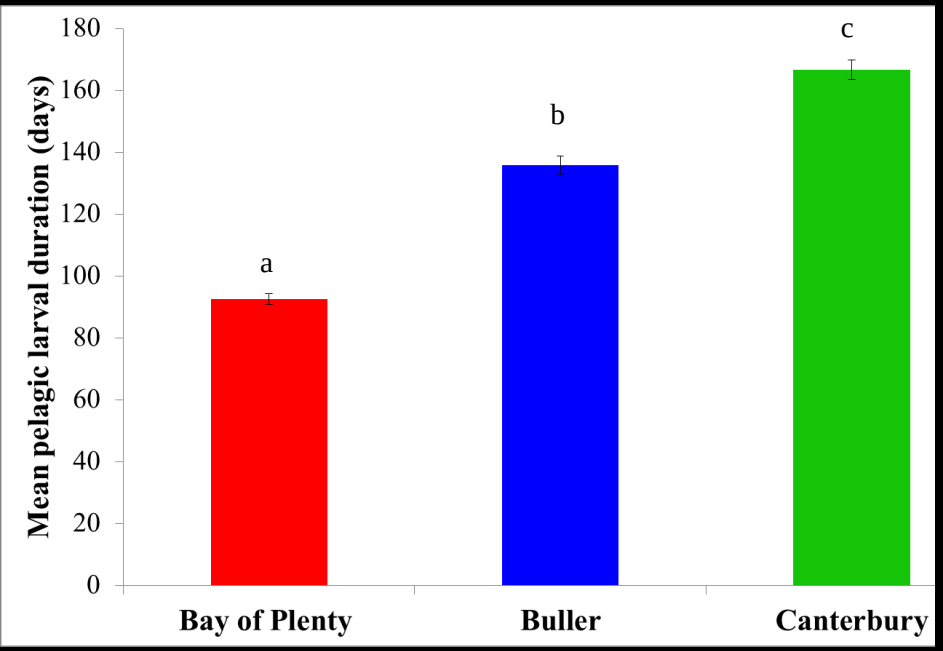
November

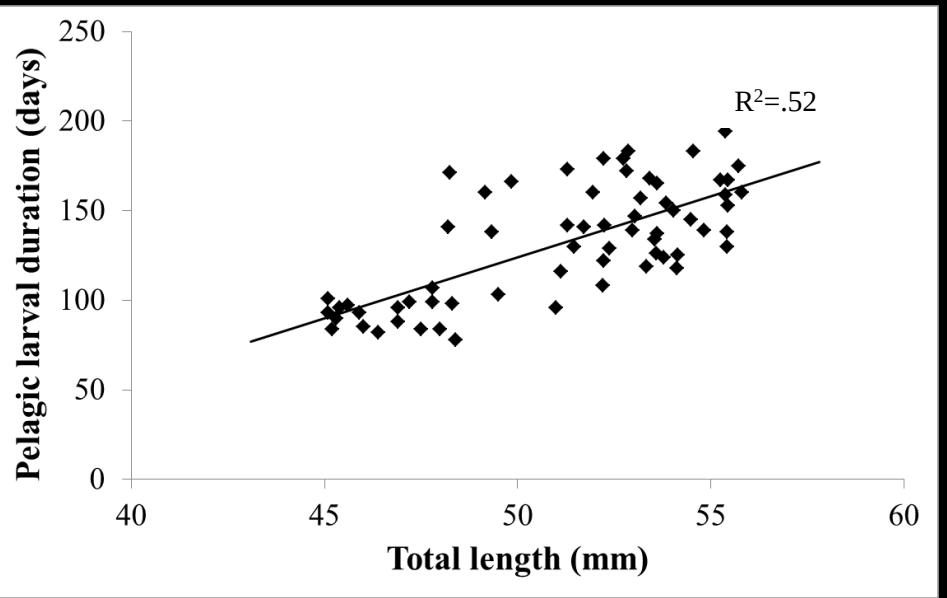


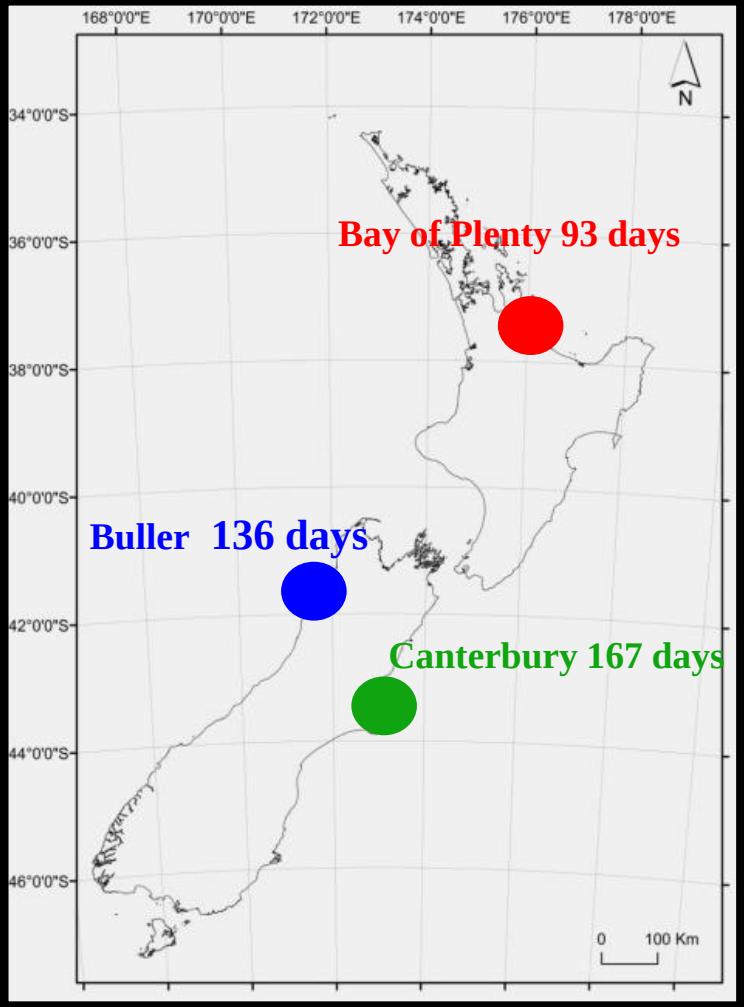


- Spatial
  - Bay of Plenty fish smaller at recruitment
  - Similarities between Buller and Canterbury
  - Buller fish 7mm larger at recruitment than Bay of Plenty
- Temporal
  - Significant differences between regions in later months

Pelagic Larval Duration

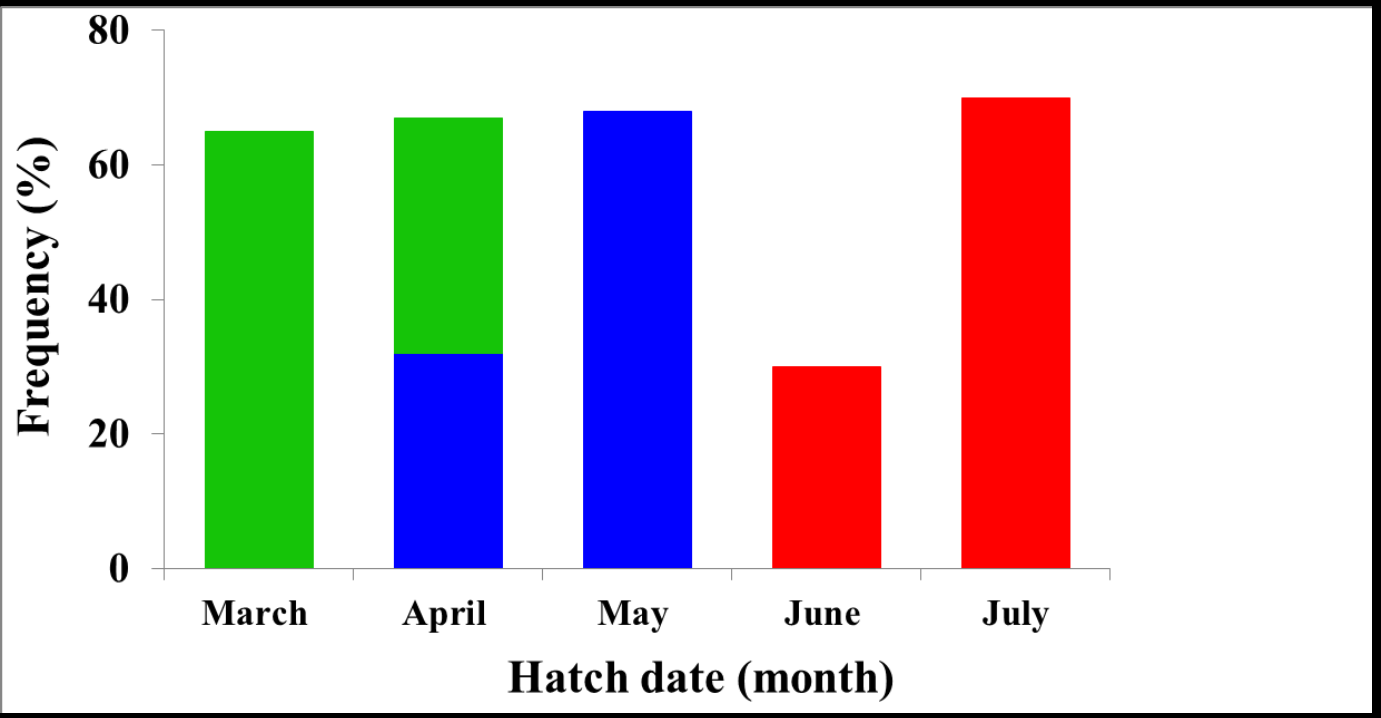


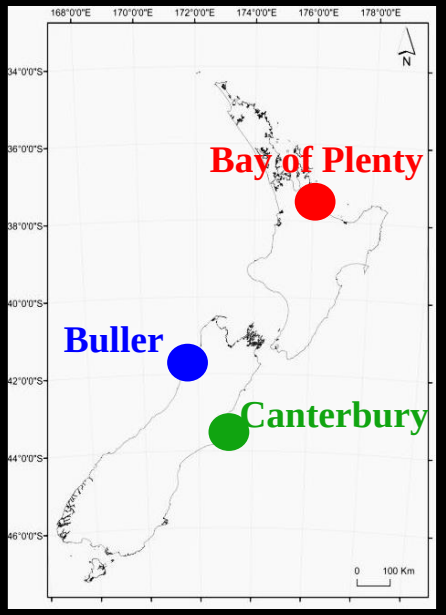




- Latitudinal
- Generally longer PLD = larger size at recruitment

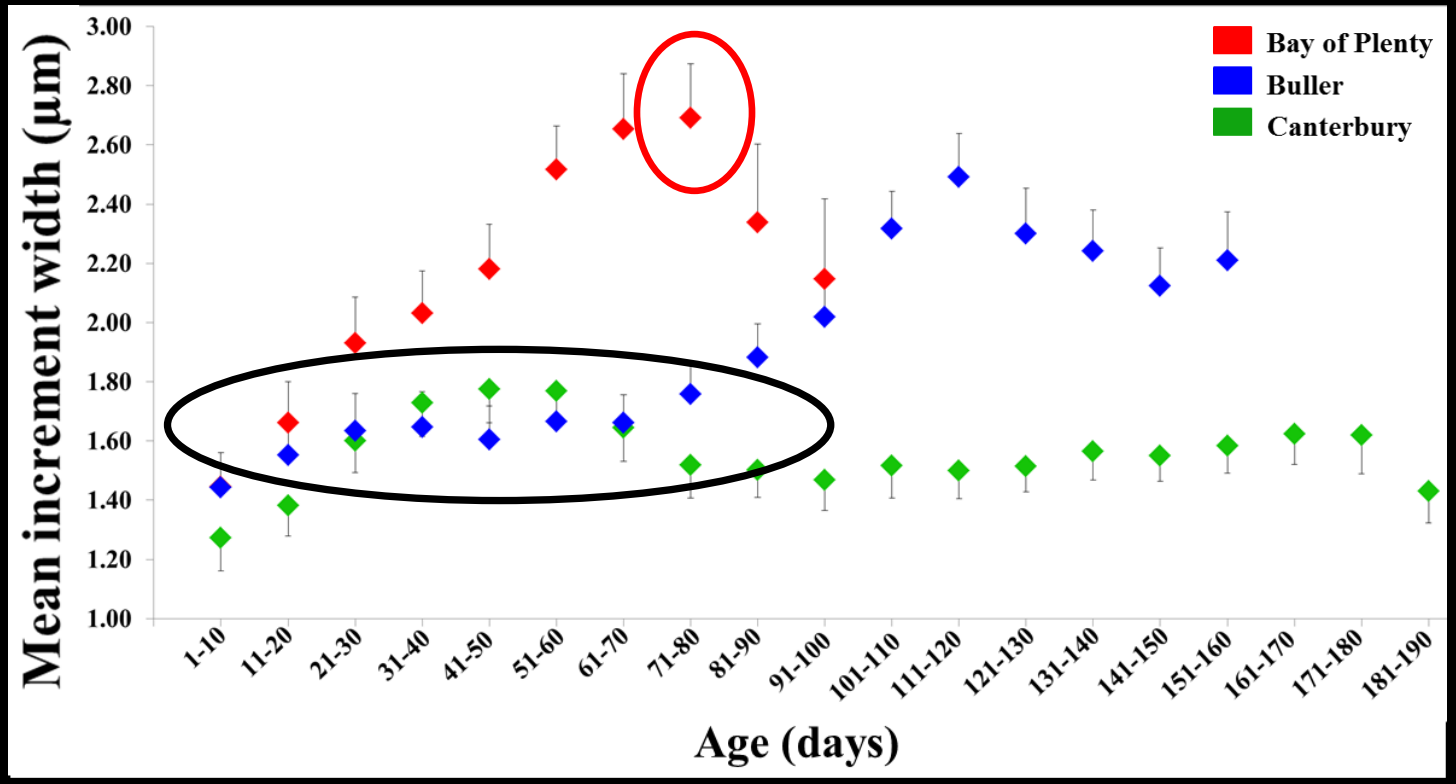
Hatch dates are different





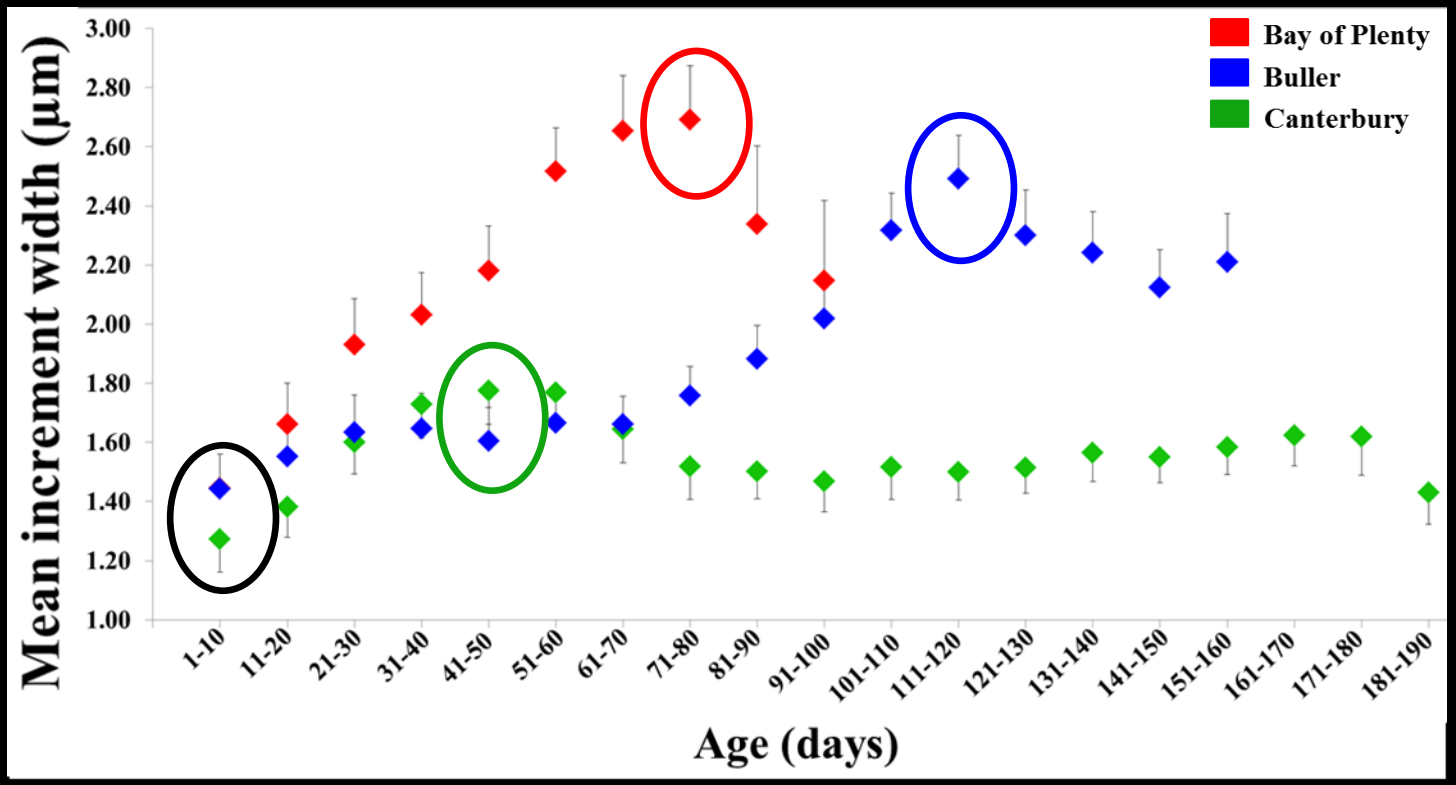
- Latitudinal variation in hatch dates
- Results consistent with gonad histological studies (Hill *et al* 2013)

Population specific growth differs



- Spatial variation
  - Bay of Plenty highest growth rates (max 2.7µm)
  - Buller and Canterbury similar growth rates up to day 71
  - Canterbury lowest growth rates

Population specific growth differs

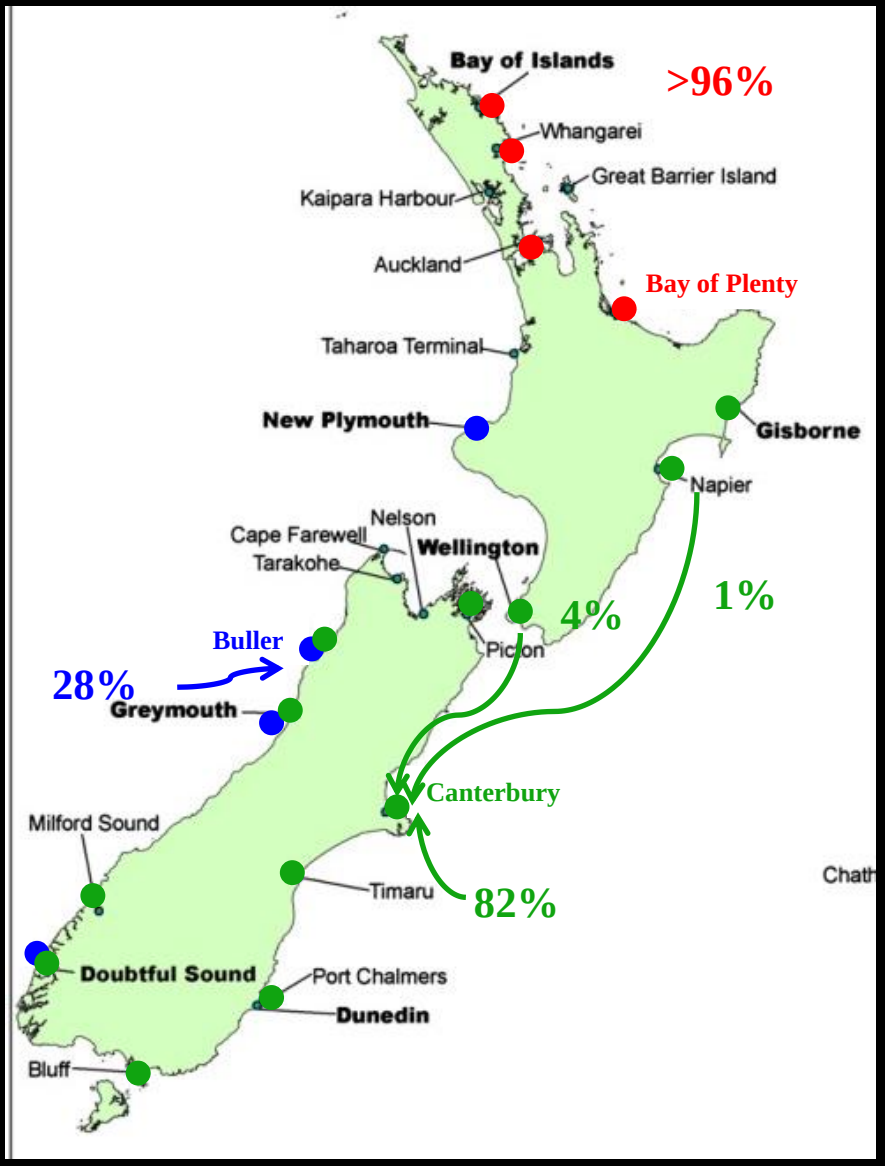


- Temporal variation
- Offset in timing of maximum growth
  - Bay of Plenty = 71-80 days
  - Buller = 111-120 days
  - Canterbury = 41-50 days

Summary

- Larval characteristics not homogenous
- Latitudinal variation
  1. Hatch dates
  2. PLD
- Spatial and temporal variation
  3. Growth rates
  4. Size at recruitment

Conclusions

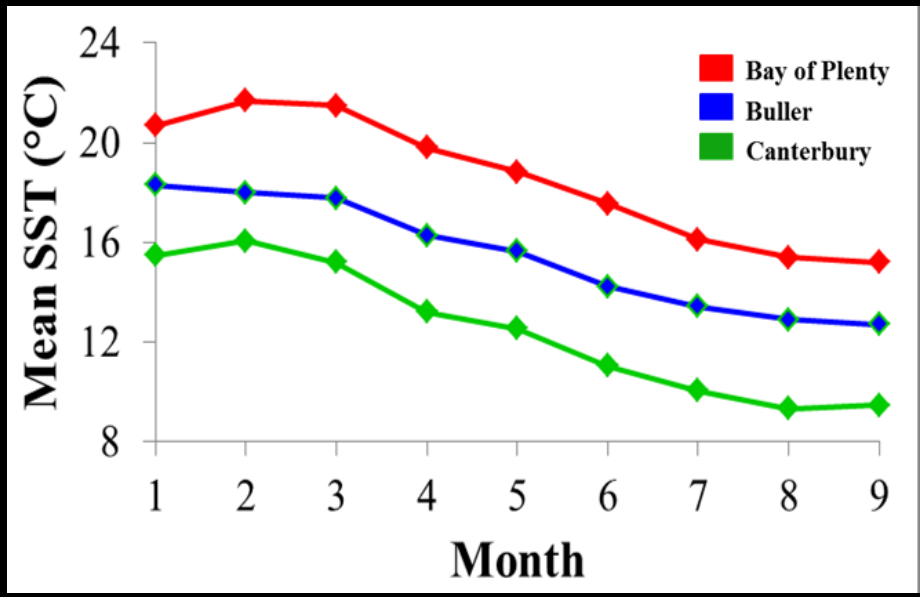


Chiswell & Rickard 2011

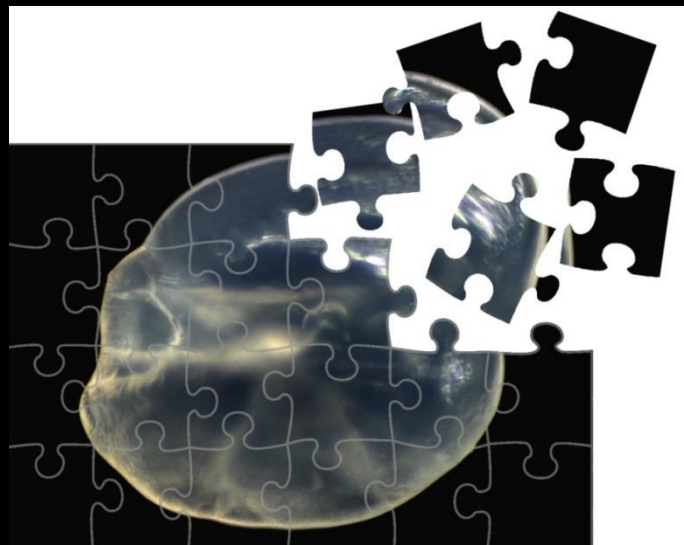
- Dispersal history?
- Growth characteristics are different
  - What does this mean?
- Otolith microchemistry
  Buller and Canterbury
  - Local retention
  - Mostly dispersal
- Genetics
  - Larval durations, mixing?
  - Panmixia highly likely

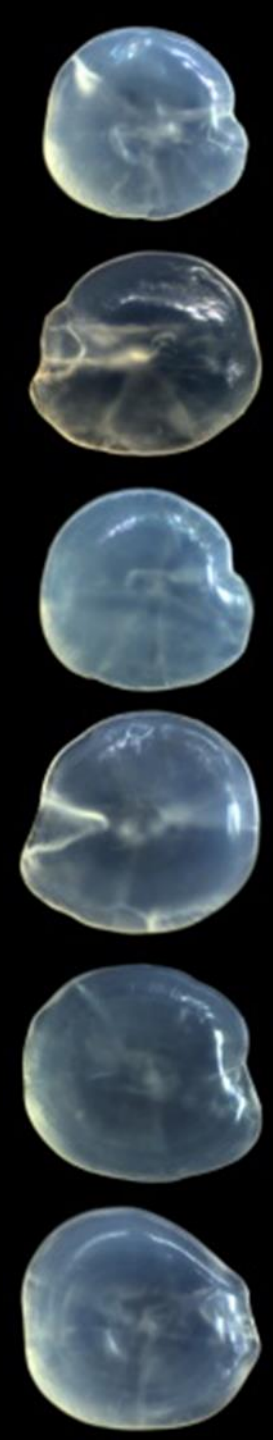
Conclusions

- Environmental history
- Growth rates
- Metabolism
- Larval duration
- Legacy effects?



- Stable isotopes
- Otolith shape
- Integrated and holistic approach required





Acknowledgements

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  - Waterways Centre for Freshwater Management
- **Fieldwork**
  - University of Waikato Coastal Marine team

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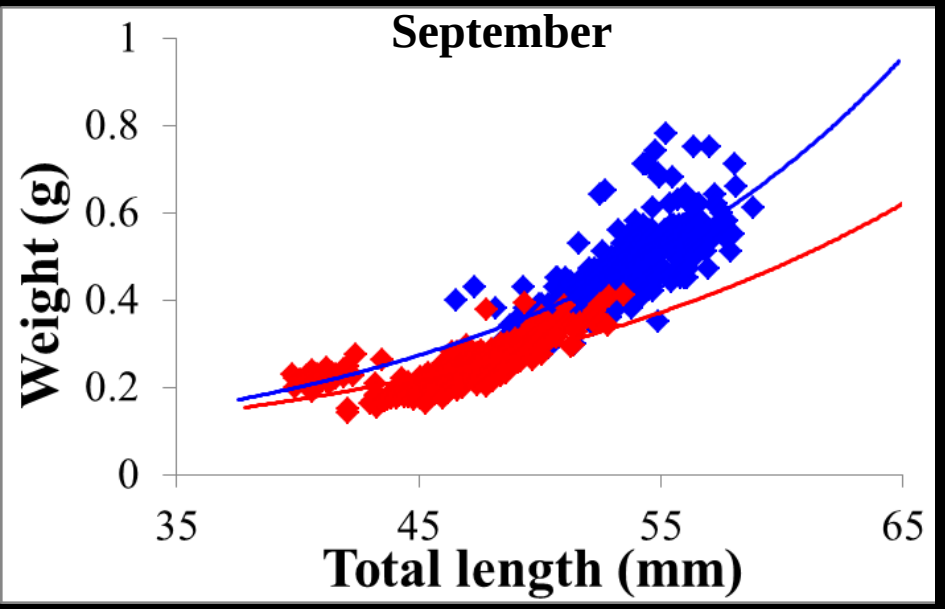
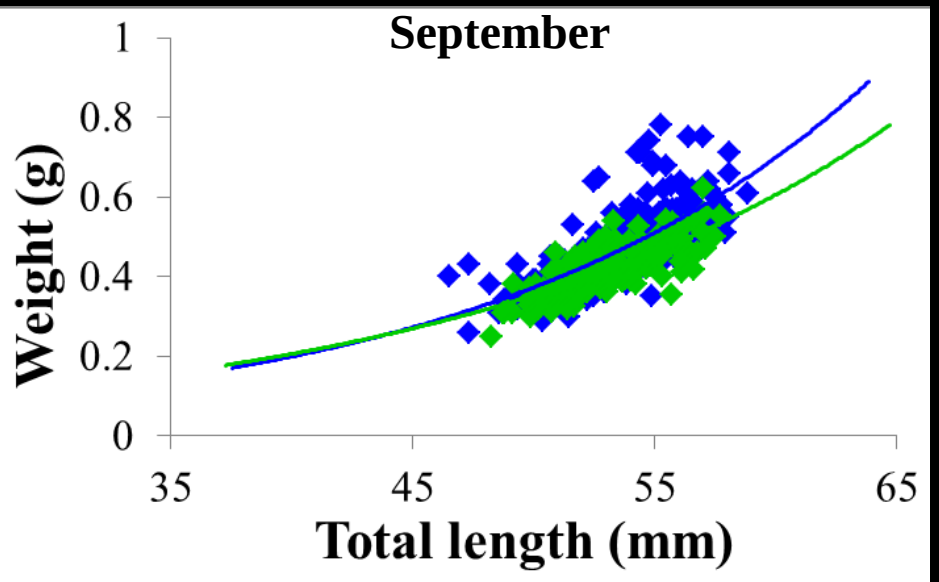
TE HUNGA MĀTAI MOANA O AOTEAROA

Growth relationship



- Slope of growth is different for Bay of Plenty and Buller populations
- Buller fish achieving better condition



- But not for Buller and Canterbury